Design and Implementation of ECG Signal Extraction and Processing System for the Diagnosis of Cardiac Arrhythmia

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ABSTRACT:
The main purpose of this article is to design a hardware and an Android application to diagnose cardiac arrhythmia at the lowest cost. In this method, the electrical signals of the heartbeat, which is the so-called ECG, are observed, and also the software has the ability to process the signals and diagnose several types of heart disease, including arrhythmia. ECG devices are very expensive and are always available in specialized laboratories and hospitals, but by designing and manufacturing this device, a person can easily take an ECG at home or anywhere, and the software acts like a doctor. And report being healthy or showing signs of illness. The proposed scheme accurately identifies an arrhythmia.

KEYWORDS: Heart, ECG, Hardware, Android, Evaluation.

1. INTRODUCTION

In today's turbulent world and the various challenges that human beings face every day and the various psychological pressures and on the other hand the industrial losses of human life, has caused 21st century human beings to face various diseases and sometimes new and emerging. Be that it did not exist before [1]. Perhaps the best evidence of this was Covid-19 disease, which somehow managed to take over the entire world, as no definitive cure has yet been found to date. But one of the most important and common diseases that human beings have been struggling with for many years is heart disease. There are many different types of heart disease, and according to various statistics published by the World Health Organization (WHO), the number of heart patients is increasing day by day. This statistic is not very favorable in our country and needs special attention.[3]

The goal is to find an easy, low-cost, safe way to view your ECG and make sure your heart is healthy. In today's world where viruses like Covid 19 are all around us, if someone has a heart condition, they are willing to put up with it but not go to the hospital. Because he is afraid of getting Covid disease, but if a cheap device is produced that anyone can buy, all families can get one of them and can easily have an ECG at home or with their family. To catch themselves [4]. In this article, the aim is to design an Android ECG device with the ability to diagnose various heart diseases, including arrhythmias. For this purpose, hardware has been designed that can convert the electrical signals of the heart from analog to digital and send them to the Android device. An Android application has been designed and programmed that can process the received signals in addition to display and diagnose and report the type of disease.

In the continuation of this article, it is divided as follows. Section 2 will provide the necessary preliminaries. In section 3, the designed hardware and software will be introduced. Section 4 will be evaluated. Section 5 provides a conclusion..

2. LITERATURE REVIEW

ECG stands for Electrocardiogram or Electrocardiograph. An electrocardiograph is a device that receives the electrical currents of the heart through electrodes that are placed on different areas of the body's skin and plots them into a diagram. This diagram is called an electrocardiogram. Contraction of all the muscles of the body is caused by an electrical change called depolarization [5]. The heart is also a muscle, so it is no exception. Depolarization wave transmission in the heart is called cardiac impulse. As the depolarization wave travels through the heart, electrical currents propagate into the tissues around the heart, and a small portion of these currents reach the surface of the skin. If currents are applied to the surface of the skin, these currents can be received. The electrical currents of the heart can be received and recorded by an

electrocardiograph as long as the other muscles of the body are not contracted [6].

The spark of each heart cycle is struck at a point in the right atrium of the heart called the sinoatrial node (SA node). The electric current produced causes the cells of the heart to depolarize, and depolarization causes the cells to contract. Electric current is distributed through conduction pathways in different parts of the heart. These paths are shown in Fig. 1 [7].
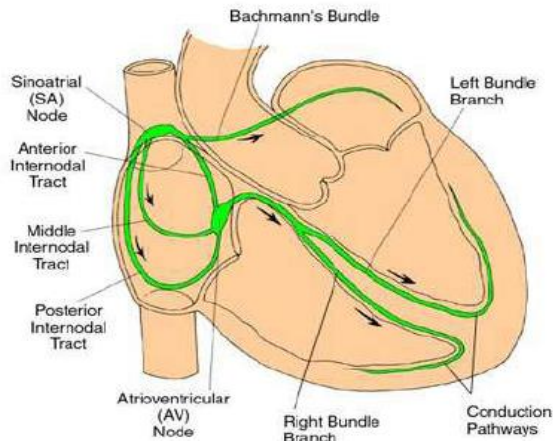

Fig. 1. Heart flow paths.

2.1. Arrhythmia

Cardiac arrhythmia means irregular heartbeat, artemia means difficulty in heartbeat rhythm (heart-rhythm) [8]. It occurs when the electrical pulses that regulate the heartbeat become disrupted and do not work properly. Types of irregular heart rhythms include Tachycardia, Bradycardia, Fibrillation, Cardiomyopathy, Heart Failure, Congenital Heart Defect, Mitral regurgitation, Angina [9]After leaving the sinus-atrial node, the electric current is distributed by the internodal pathways in the right and left atria. The current then must pass through a structure called the atrioventricular node (AVnode) to pass through the atria and ren to the lower regions (ventricles). The electric current stops at this point for a while and then enters a highway called the bundle. of His) becomes. This highway is then divided into two paths called right and leftbundle branches, which distribute the flow in the right and left ventricles. The pathways eventually lead to very thin fibers called purkinje fibers, which transmit electrical waves to myocardial cells [10].
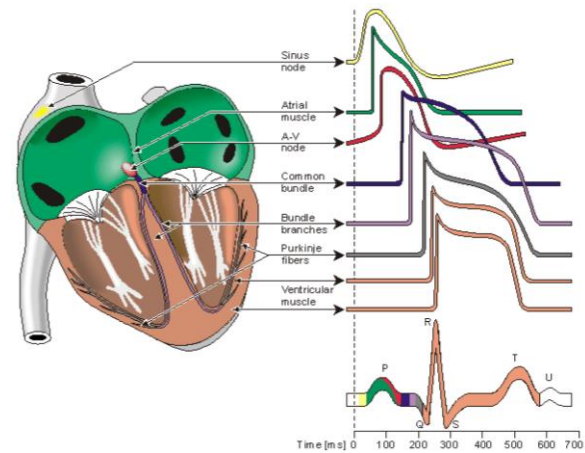

Fig. 2. How the signal is formed.

3. PROPOSED METHOD

The AD8223 heart rate module is actually an electrocardiographic module for physiological measurements. Using this module, the heart rate can be measured accurately. This module is a low-power precision converter that is capable of working in noisy conditions and has a filter. Some with amplifier in order to optimize the output signals. This module comes with three pads or leads that are installed near the heart and on the chest. This circuit allows the heart rate to be measured by microcontrollers. This module can be used in medical equipment. One of the most important advantages of this module is its accurate output and easy installation on the body, which can be easily used in wearable gadgets and remote health monitoring devices, as well as heart rate monitoring. Features of this module include three electrode pads for connecting to the body, adjustable bipolar high pass filter, low current consumption, signal signal gain 100, low pass filter with adjustable gain, operating voltage 2 to 3.5 volts, very reasonable price, has Communication cables for connection. Fig. 3 shows this module.

Fig. 3. Module AD8232.

In this project, the output of Fig. 4 was connected to the input of ADC5 microcontroller and using an analog-to-digital converter, the input values were measured at high speed at any time, and in order to be able to send at high speed from the serial port, it was converted to an 8-bit number. We can send the equivalent of an 8-bit character from a serial port.
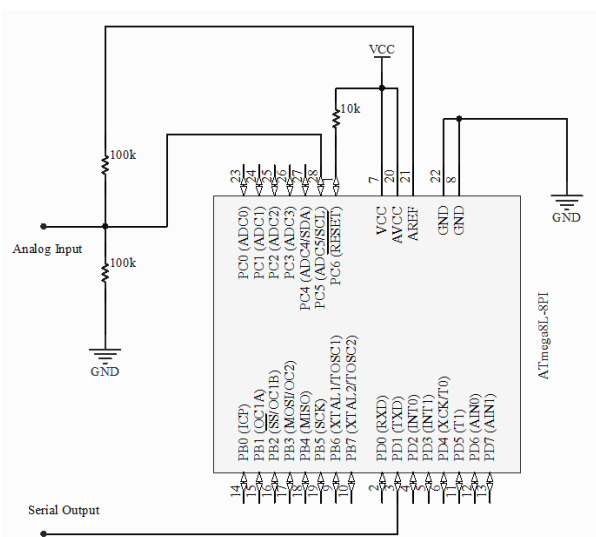

Fig. 4. Schematic circuit of connecting microcontroller pins

For the program prepared in BASCOMAVR programming environment, Atmega8 microcontroller is selected and its analog-to-digital converter is set up with a reference voltage of 2.56 volts, then in an infinite loop the analog input values are read from the ADC5 input and 2 bits to The right shift is given to make it 8-bit, the reason is that the data is converted to 8-bit because we want to send the serial port in the form of equivalent characters at a very high speed. As we know, for each character on the computer keyboard, there is a number called the ASCII ASCII code, whose values are from 0 to 255, which should fit in one. And when these characters, which are sent in the form of consecutive character strings, are received in the receiver, they must be converted to ASCII code again so that we can draw a graph of it from the numbers obtained in the time dimension and we can perform the necessary analysis on it.

3.1. How to transfer data to an Android phone

In this research, the Bluetooth module was selected due to its very low consumption and reasonable price in the market and the ability to send data in that volume. In the following, we will introduce the selected Bluetooth module.

As shown in Fig. 5, the HC05 module has RX and TX serial ports that can be adjusted to different standard transmission rates and can operate from 3 to 5 volts.

With this module, we can easily use the characters produced by the microcontroller. Which are sampled from heart signals at high speed serially to any new device such as Android phone.
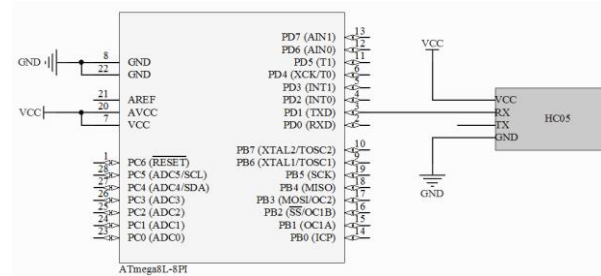

Fig. 5. Schematic circuit of how the Bluetooth module connects to the Atmega8 microcontroller.

3.2. Android app for displaying and analyzing heart rate

The software required in the Basic4Android programming environment, which is called B4A for short, has become one of the most popular programs for producing various applications in recent years, and it is very easy and pleasant to work with. So that everyone with two days of study and a few hours of training will be able to program in this environment. Also, the website www.B4X.com provides a variety of open source resources to its users. The following is the content of the program with brief descriptions of each of the sub-programs.

4. 4-EVALUATION

Now with the results we want to see if Android software can help diagnose heart disease based on the data obtained and the shape of the heartbeat? The answer is yes. In this project, based on the tests performed and the results obtained, we were able to diagnose fast arrhythmia, slow arrhythmia, irregular arrhythmia without a doctor. Fig. 6 shows the device built and Fig. 7 shows the Android output.
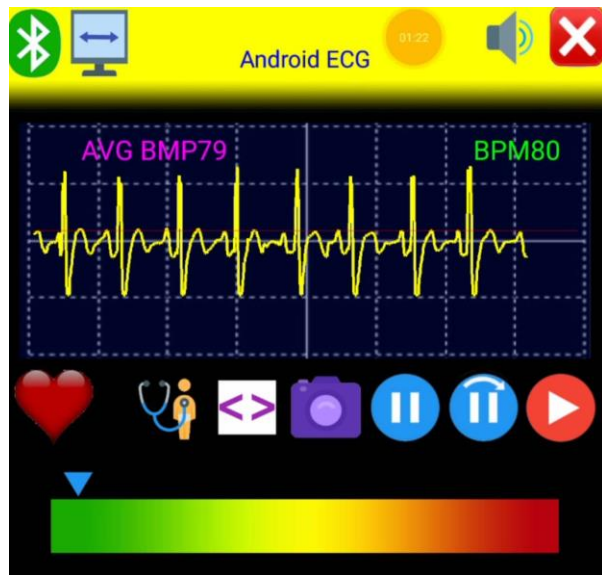

Fig. 6. Built-in device.

Fig. 7. View of Android application.

In this software, we sample for 60 seconds and measure the number of heartbeats and the time interval between its peaks and get an average value. Fig. 8 shows this waveform.

Fig. 8. Received signal waveform.

Then, by pressing the test button, the software starts displaying the heart rate and compares each of the 10 samples read with the average value. In this software, we multiplied and divided the average value by 1.2 and obtained a high range and a low range. For example, if the average heart rate is 72 beats per minute, the upper range is obtained by multiplying the number 72 by 1.2, which is 86.4, and by dividing the number 72 by 1.2, the lower range is 60. Now, if all 10 of the read samples are between these two ranges, it means that the heart rate is completely normal, uniform and regular. But if the number of differences between the heart rate and the average value is more, it means that the heart is working irregularly, considering that the sample number is 10, if two numbers are different, it means that the person beats 20% of his heart irregularly, and if the number of differences reaches 10, it means 100%. The heart beats irregularly. And with this software, we could easily detect an arrhythmia, ie irregular heartbeat. Also, considering that the normal heart rate should be between 70 and 80 beats per minute, we can easily detect fast or slow arrhythmias by measuring the heart rate.

5. CONCLUSION
In this article, a hardware and an Android application were designed and built to diagnose cardiac arrhythmias. Electrical signals are observed in the built device and also the designed software is capable of processing signals and detecting arrhythmias. The results of the evaluation of this module report the health or symptoms of the disease. The proposed scheme accurately identifies an arrhythmia.

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